WILPINJONG COAL MINE

Annual Review 2022
Surface Water Compliance

Prepared for:

Wilpinjong Coal Pty Ltd
1434 Ulan Wollar Road
WILPINJONG NSW 2850

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BASIS OF REPORT

This report has been prepared by SLR Consulting Australia Pty Ltd (SLR) with all reasonable skill, care and diligence, and taking account of the timescale and resources allocated to it by agreement with Wilpinjong Coal Pty Ltd (the Client). Information reported herein is based on the interpretation of data collected, which has been accepted in good faith as being accurate and valid.

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DOCUMENT CONTROL

Reference	Date	Prepared	Checked	Authorised
665.10014.02305-R01-v1.0	18 March 2023	A Skorulis & K Selvaratnam	A Basson	A Basson
665.10014.02305-R01-v2.0	31 March 2023	A Skorulis & K Selvaratnam	A Basson	A Basson

EXECUTIVE SUMMARY

This report documents the analysis and data considered for the review of flow and water quality trends at Wilpinjong Creek, Wollar Creek and Cumbo Creek near Wilpinjong Coal Mine (WCM) to fulfil surface water reporting requirements for the WCM 2022 Annual Review. The report is presented in three sections:

1. An overview of the volume and quality of discharge under EPL 12425 including: [**Section 3**]
    a. Previously approved discharge from EPL Point 24 and EPL Point 30; and
    b. The approved discharge of excess mine water (EMW) under emergency provisions to watercourses adjacent to WCM in late 2022.
2. Analysis of flow and quality data from the Wilpinjong Creek and Cumbo Creek gauging stations, considering long-term rainfall trends, licenced discharge from WCM and upstream at Moolarben Coal (MC)[**Section 4**].
3. Assessment of electrical conductivity (EC), pH, and turbidity observations at Wilpinjong, Cumbo and Wollar Creeks during the 2021-2022 water year in respect to baseline data (pre-mining as defined in the Surface Water Management Plan (SWMP)) as well as Water Quality Impact Assessment Criteria for downstream monitoring sites within Cumbo and Wilpinjong Creeks, as defined in the current SWMP [**Section 5**].

Discharge under EPL12425 from EPL Point 24 (the RO Plant) and EPL Point 30 (Pit 8 Clean Water Dam) occurred within the stipulated discharge limits throughout 2022. CF Hydrometrics have been engaged by WCPL to evaluate compliance with EPL Condition 2.5 on a monthly basis (pertaining to turbidity at EPL Point 30). CF Hydrometrics have confirmed that no licence exceedances occurred within the EPL Return Period (8 Feb 2022 to 7 Feb 2023).

Analysis of continuous data at the WCM gauging stations in 2022 indicated elevated flow conditions at Cumbo Creek and Wilpinjong Creek sites in response to above average rainfall conditions. Flow was also influenced later in 2022 by the permitted discharge of EMW from WCM and MC. For most of 2022, water quality data from continuous monitoring (pH and electrical conductivity (EC)) was consistent with previous wet periods, while some localised influence on water quality was observed late in 2022, due to the permitted discharge of EMW. Reviews assessing the influence of EMW discharge have shown resultant water quality observations are within the natural variation ranges, and that any influence appears to be local and short-term.

Analysis of the available surface water quality data from monthly grab samples in 2022 does not indicate observable impacts from the WCM mining operations on the adjacent creeks, for the majority of the assessed period. Two Wilpinjong Creek downstream monitoring locations recorded exceedances of water quality monitoring criteria (pH upper limit), with the following point summarising the key findings from the investigation of the trigger exceedances:

- The pH observations exceeding the upper trigger level for downstream Wilpinjong Creek may be within the normal range for pH at these locations. The 80th percentile pH from baseline data for these downstream sites is pH 7.9, which is above the established trigger level of pH 7.7. The RO plant was observed to discharge within defined EPL limits in 2022, but the upper bound of these limits is higher (pH 8.5) than the upper pH limit at downstream Wilpinjong Creek (pH 7.7).

The following recommendations are proposed to enable a more relevant and robust analysis of monitoring data:

- The pH trigger level could be revised to reflect observed baseline data to provide a more meaningful indication of when WCM may be impacting water quality on Wilpinjong Creek.
- Sampling methodology of the downstream water quality sites at Cumbo Creek could be updated to consider the potential influence of Ulan-Wollar Road on water quality observations at the time of sampling. When flow is observed at sites downstream of Ulan-Wollar Road, runoff contribution from Ulan-Wollar Road should be checked, noted on sampling sheets, and photographed at the time of sampling . This will help evaluate the contribution of runoff from the road on the collected water sample.

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1 Introduction

1.1 Background

This report contains the analysis and information required for the review of flow and water quality trends at Wilpinjong Creek, Wollar Creek and Cumbo Creek near Wilpinjong Coal Mine (WCM). It serves as a supplementary document to the review of hydrogeological data conducted by SLR Consulting Pty Ltd (SLR) for the 2022 Groundwater Annual Review and 2021-22 Water Year Licensing Audit. This report presents information on the following items:

1. An overview of climatic conditions during 2022.
2. An overview of the volume and quality of water discharged from WCM during 2022 at the Licenced Discharge Points (LDPs) permitted under Wilpinjong Coal Pty Limited (WCPL) Environmental Protection Licence (EPL) EPL12425.
3. Cause-and-effect analysis of data from the Wilpinjong Creek upstream (WILGSU) and downstream (WILGSD), and Cumbo Creek upstream (CCGSU) gauging stations, compared to the long-term rainfall trend and discharge from WCM and other regional mines.
4. Assessment of key water quality criteria at local creeks during the 2021-2022 water year in respect to baseline data (pre-mining, as defined in the SWMP), as well as Water Quality Impact Assessment Criteria for downstream monitoring sites within Cumbo and Wilpinjong Creeks, as defined in the current Surface Water Management Plan (SWMP).

The report consists of commentary on the cause-and-effect analysis and trigger level assessment, with the inclusion of supporting figures. The Wilpinjong surface water monitoring, flow gauging stations and discharge locations are presented in **Figure 1**.

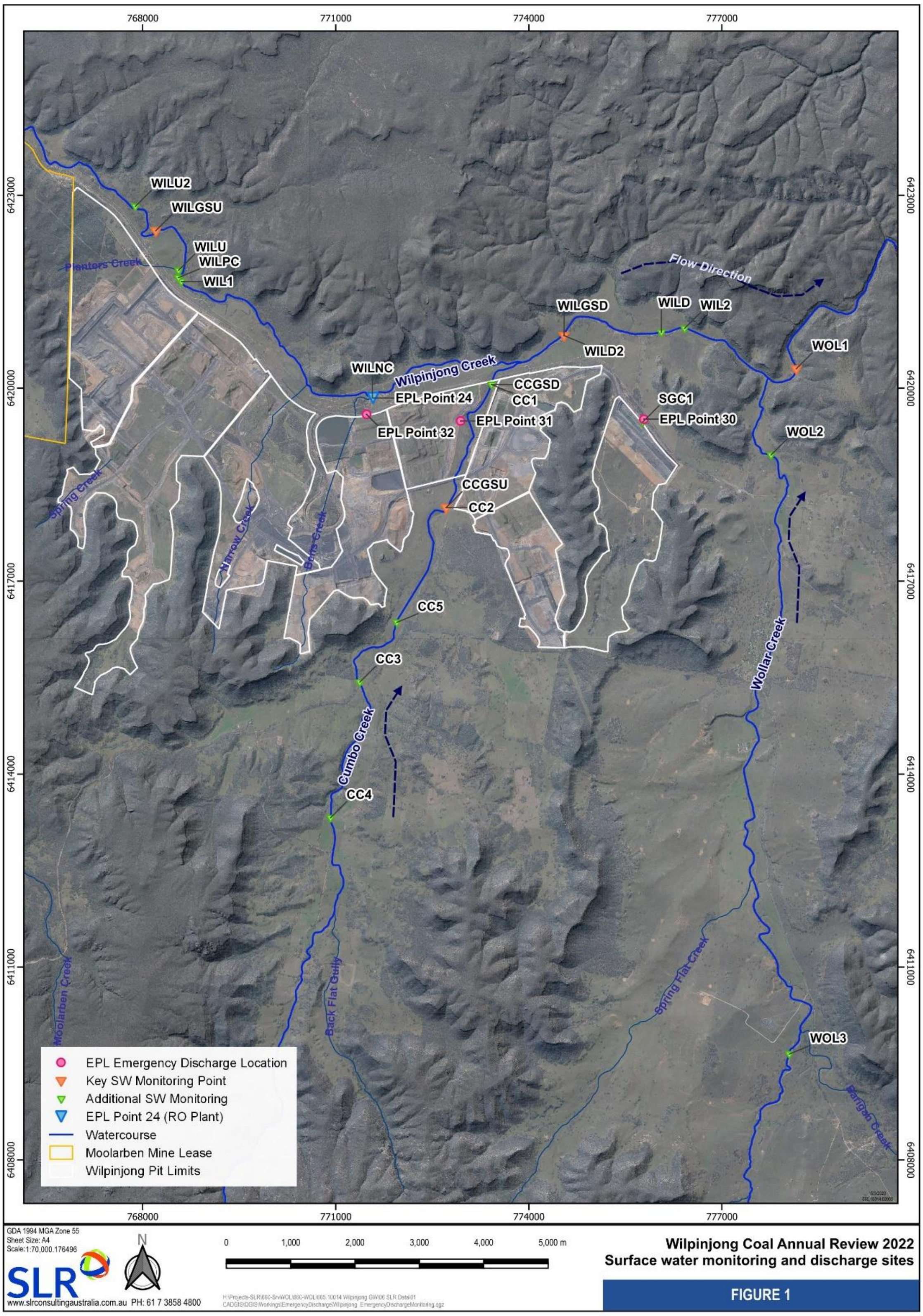

Figure 1 Surface water monitoring and discharge sites

2 Climate

New South Wales experienced an exceptionally wet year in 2022 with the state-averaged annual total being the second highest on record (Bureau of Meteorology, 2023). **Table 1** displays the monthly and annual rainfall records for 2016-2022 compared to the long-term averages at the Wollar (Barrigan St) BOM station, which clearly demonstrates the very wet conditions experienced in 2022 following the wet conditions experienced through 2020 and 2021, which was preceded by drought conditions from 2017 to the end of 2019. The annual total rainfall recorded in 2022 was 989 mm, 65% higher than the long-term average of 593.8 mm.

Table 2 presents the total rainfall observed by the on-site rainfall gauge during 2022. Overall, rainfall recorded on-site at WCM is slightly higher than at the Wollar BOM station with a total for 2022 of 998.2 mm. In comparison to the Wollar BOM station, significantly higher rainfall was observed on-site at WCM during April, July and October and significantly lower rainfall was observed at WCM during January and March.

Other notable wet years, since WCM operations commenced and not included in **Table 1,** are 2007 (840 mm), 2008 (785.5 mm), 2010 (1,084 mm), 2012 (712.2 mm). Notable dry years during WCM operations, not included in **Table 1** are 2006 (330.9 mm) and 2009 (481.2 mm)

Significant variation in annual rainfall is a key influence on surface water flow and can influence water chemistry.

Table 1 BOM rainfall station 062032 - recent monthly and annual rainfall vs long term average (mm)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Avg	**67.1**	**62.6**	**55.1**	**39.3**	**37.2**	**43.8**	**43**	**41.1**	**41.9**	**52.2**	**56.7**	**60.7**	**593.8**
2016	101.2	10.4	21.4	3.0	67.0	114.2	82.4	44.0	181.2	74.2	41.0	36.2	**776.2**
2017	13*	31.0	127.0	19.0	24.4	12.0	1.4	25.6	2.0	30.0	62.6	86.4	**421.4**
2018	13.4	66.2	41.4	47.0	12.6	22.0	6.5	25.5	51.0	48.5	44.4	117.6	**496.1**
2019	72.0	5.0	110.5	0.0	20.0	6.0	4.0	10.0	23.0	7.0	30.0	6.0	**293.5**
2020	37.0	151.0	110.2	118.0	35.0	31.3	86.0	36.0	75.7	128.0	21.5	149.3	**979.0**
2021	43.8	107.0	157.5	2.5	11.0	82.0	68.2	21.0	45.0	72.0	183.0	134.0	**927.0**
2022	169.0	17.0	139.5	65.0	38.0	14.5	109.0	100.5	94.5	126.0	85.0	31.0	**989.0**

* No rainfall recorded at Wollar (Barrigan St). Rainfall from Bylong (Glenview) – 062107 used.

Table 2 Wilpinjong site rainfall data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
2022	101.4	67.1	62.6	55.1	39.3	37.2	43.8	43	41.1	41.9	52.2	56.7	**998.2**

The cumulative rainfall departure (CRD) shows trends in actual rainfall over time relative to the long-term average and provides a historical record of relatively wet and dry periods. A positive slope in the CRD indicates periods of above average rainfall, while a negative slope indicates periods of below average rainfall. A level trace indicates rainfall conditions are equal to average rainfall conditions.

For the calendar years 2020- 2022 WCM experienced significantly above average rainfall conditions, as indicated by a sharp upward trend in the CRD. This contrasts with the declining CRD trend preceding this period from mid-2017 to the end of 2019 (**Figure 2**).

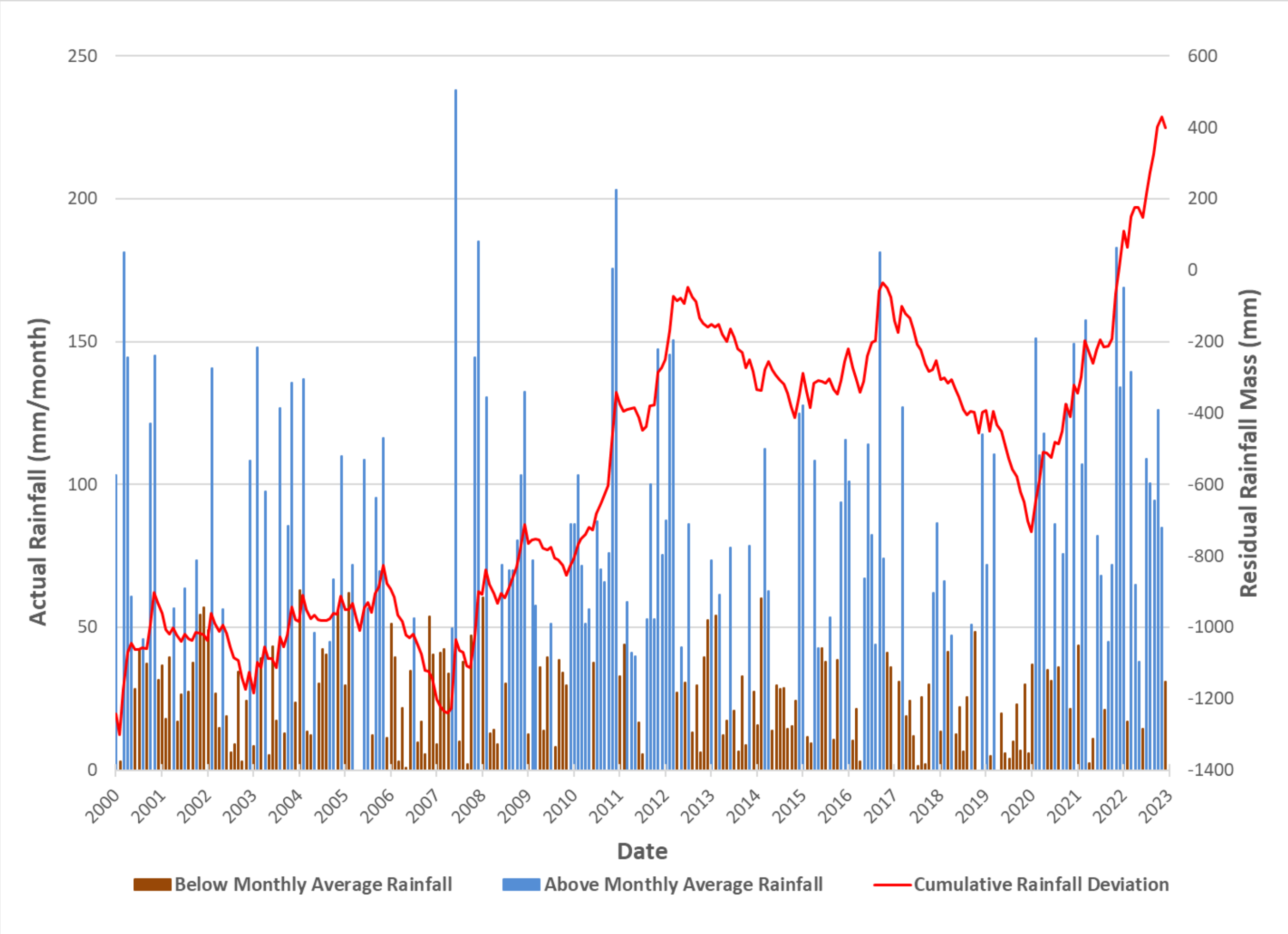

Figure 2 Monthly rainfall and CRD

3 Licenced Discharge

Under Environmental Protection Licence (EPL) 12425, WCM is allowed to discharge water from site to Wilpinjong Creek from the following locations (see **Table 3**):

- EPL Point 24 - Product water from the RO treatment plant is discharged to Wilpinjong Creek. The daily discharge limit from the RO Plant is 6.5 ML/day. The EPL requires monitoring of electrical conductivity (EC), pH, oil and grease, turbidity, and total suspended solids (TSS).
- EPL Point 30 – Discharge from the Pit 8 clean water diversion (CWD) dam to the downstream reach of Slate Gully Creek before it enters Wilpinjong Creek. There is no daily discharge limit and the EPL reflects Wilpinjong Coal's position that the water quality (i.e., measured as turbidity) from the Pit 8 clean water diversion must be equal to or better than the receiving water in Wilpinjong Creek.

During 2022, due to the ongoing above average rainfall conditions (see **Section 2**) and the high potential for an uncontrolled off site water discharge, WCM was granted two licence variations for the following periods by the NSW Environmental Protection Authority (EPA) to discharge excess mine water (EMW) to Wilpinjong Creek:

- *WCM Discharge Period 1*: Discharge to Wilpinjong and Cumbo Creeks between 31 October 2022 and 25 November 2022 occurred from three locations (EPL Points 30, 31, 32) (see **Table 3**) with a total permissible discharge of 71 ML/day comprising the best available onsite water quality. (Discharge during this period was authorised under a separate exemption granted on the 31st of October 2022.)
- *WCM Discharge Period 2*: Discharge to Wilpinjong Creek between 15 December 2022 and 1 January 2023 occurred at two locations (EPL Points 30 and 32) (see **Table 3**) with a total permissible discharge of 20 ML/day and again comprising the best available onsite water quality. The decrease in allowable daily discharge volume was proposed by WCM to related to the reduction in natural flow within the receiving environment following a short period of drier conditions.

Table 3 Wilpinjong emergency water discharge locations

Site	Description
EPL Point 32	- EMW from Pit 2 was discharged to Wilpinjong Creek. - The water make-up varied over the discharge period, as the Pit 2 dam water was periodically simultaneously released with treated water from the Reverse Osmosis (RO) Plant. - Water was released to Wilpinjong Creek using a combination of the existing RO Plant discharge infrastructure and natural drainage channels. - The daily discharge limit for WCM Period 1 from EPL Point 32 was 35 ML/day. - The daily discharge limit for WCM Period 2 from EPL Point 32 was 15 ML/day.
EPL Point 31	- EMW from Pit 4 was discharged to Cumbo Creek, a tributary of Wilpinjong Creek. The discharge location was approximately 1.3 km from the confluence with Wilpinjong Creek. - The daily discharge limit for WCM Period 1 from EPL Point 31 was 18 ML/day. - No discharge was permitted for WCM Period 2 from EPL Point 31.
EPL Point 30	- EMW from Pit 8 was discharged to Wilpinjong Creek via the Slate Gully drainage line, utilising existing clean water diversion infrastructure. - The daily discharge limit for WCM Period 1 from EPL Point 30 was 18 ML/day. - The daily discharge limit for WCM Period 2 from EPL Point 30 was 5 ML/day. - Ongoing discharge of collected surface water above mining operations from the Pit 8 clean water dam outside of emergency discharge periods is permissible, as was originally licenced at this location.

Site	Description
EPL Point 24	- Product water from the RO treatment plant is discharged to Wilpinjong Creek. - The daily discharge limit from the RO Plant is 6.5 ML/day. - Ongoing discharge of product water from the RO treatment plant outside of emergency discharge periods is permissible.

3.1 Emergency Discharge Summary

Both licence variations included a requirement to submit a report to the NSW EPA reviewing potential changes in downstream surface water quality that may have been caused by the discharge (SLR (2022b) and SLR (2023)). A summary of the key findings from each of these reports is provided in the points below.

SLR (2022b) – Discharge Period 1

- 1,287 ML out of an allowable 1,775 ML was discharged.
- The EC of discharge water was between 3,500 and 4,500 µS/cm, which was higher than the EC of the receiving water in Wilpinjong Creek prior to discharge.
- Turbidity was generally <10 NTU at all discharge sites. This is lower than the turbidity of the receiving water in Wilpinjong Creek prior to discharge.
- pH was between 7 and 8.5 at all discharge sites, this is generally consistent with recent pH of the receiving water in Wilpinjong Creek prior to discharge.
- The discharge of EMW temporarily influenced the surface water EC in Wilpinjong Creek. The elevated EC in Wilpinjong Creek was within the range of natural variation and declined following the cessation of WC discharge. There were no discernible changes in EC observed beyond the range of natural variation further downstream at the Goulburn River.
- It is unlikely that water quality (in particular EC) in Goulburn River was significantly influenced by discharge of EMW from WCM during Discharge Period 1 in October/ November 2022. This is due to high flows induced by high rainfall events in the Goulburn River catchment compared to EMW discharge volumes.

SLR (2023) – Discharge Period 2

- 320 ML out of an allowable 360 ML was discharged.
- The EC of discharge water was between 3,250 and 4,500 µS/cm and observed to be reasonably consistent at each discharge location. This is higher than the EC of the receiving water in Wilpinjong Creek prior to discharge.
- Turbidity was generally <10 NTU at all discharge sites. This is lower than the turbidity of the receiving water in Wilpinjong Creek prior to discharge and lower than historical observations.
- pH is between 7.5 and 8.5 at all discharge sites, this is generally consistent with recent and historical pH of the receiving water in Wilpinjong Creek prior to discharge.

- The discharge of EMW from WCM during December 2022 and early January 2023 influenced the surface water EC in Wilpinjong Creek, downstream of the two discharge points during the discharge period. However, it appears that this influence was temporary and limited in extent. Elevated EC in Wilpinjong Creek was within the range of natural variation and declined following the cessation of WCM discharge. There were also no discernible changes in EC observed, beyond the range of natural variation, further downstream at the Goulburn River.

3.2 Licenced Discharge

Under EPL12425, discharge of treated water from WCM to Wilpinjong Creek is regulated at two locations, specifically EPL Point 24 and EPL Point 30 (**Section 3**). Discharge at EPL Point 24 is via the RO plant while discharge at EPL Point 30 occurs from the clean water diversion (CWD) dam located near Pit 8, to the downstream reach of Slate Gully Creek before it enters Wilpinjong Creek.

The following sections provide further detail on EPL conditions at these discharge points, and an overview of the quality and volume of water discharged in 2022. The quality of discharged water will contribute to water quality observations in Wilpinjong Creek and may be relevant when assessing surface water compliance for 2022.

3.2.1 EPL Point 24 – RO Plant

WCM was approved to discharge up to 5 ML/day via the RO plant at EPL Point 24, which treats water from on-site water retention dams. On 10 October 2022, EPL 12425 was updated to increase the discharge limit at EPL Point 24 to 6.5 ML/day. EPL 12425 specifies limits for the quality and monitoring frequency of water that may be discharged from site (**Table 4**).

Table 4 EPL Point 24 – RO Plant Discharge Limits

Pollutant	Unit of Measurement	Required Monitoring Frequency	Limit
Conductivity	Micro-Siemens per centimetre (µS/cm)	Continuous during discharge	500
Oil and Grease	milligrams per litre (mg/L)	Weekly during any discharge	10.0
pH	pH unit	Continuous during discharge	6.5 – 8.5
Total Suspended Solids (TSS)	milligrams per litre (mg/L)	Weekly during any discharge	50

Discharge volumes and water quality (for EC and pH) from the RO plant during 2022 are presented in **Figure 3**, which presents daily mean values for discharge, EC and pH from continuous monitoring are alongside weekly laboratory samples for EC and pH. EPL limits (**Table 4**) are not exceeded for any analytes during 2022, also noting that the maximum TSS observation in 2022 was 2 mg/L, which is less than historical observations at WCM monitoring sites (avg TSS of 54 mg/L over 81 observations).

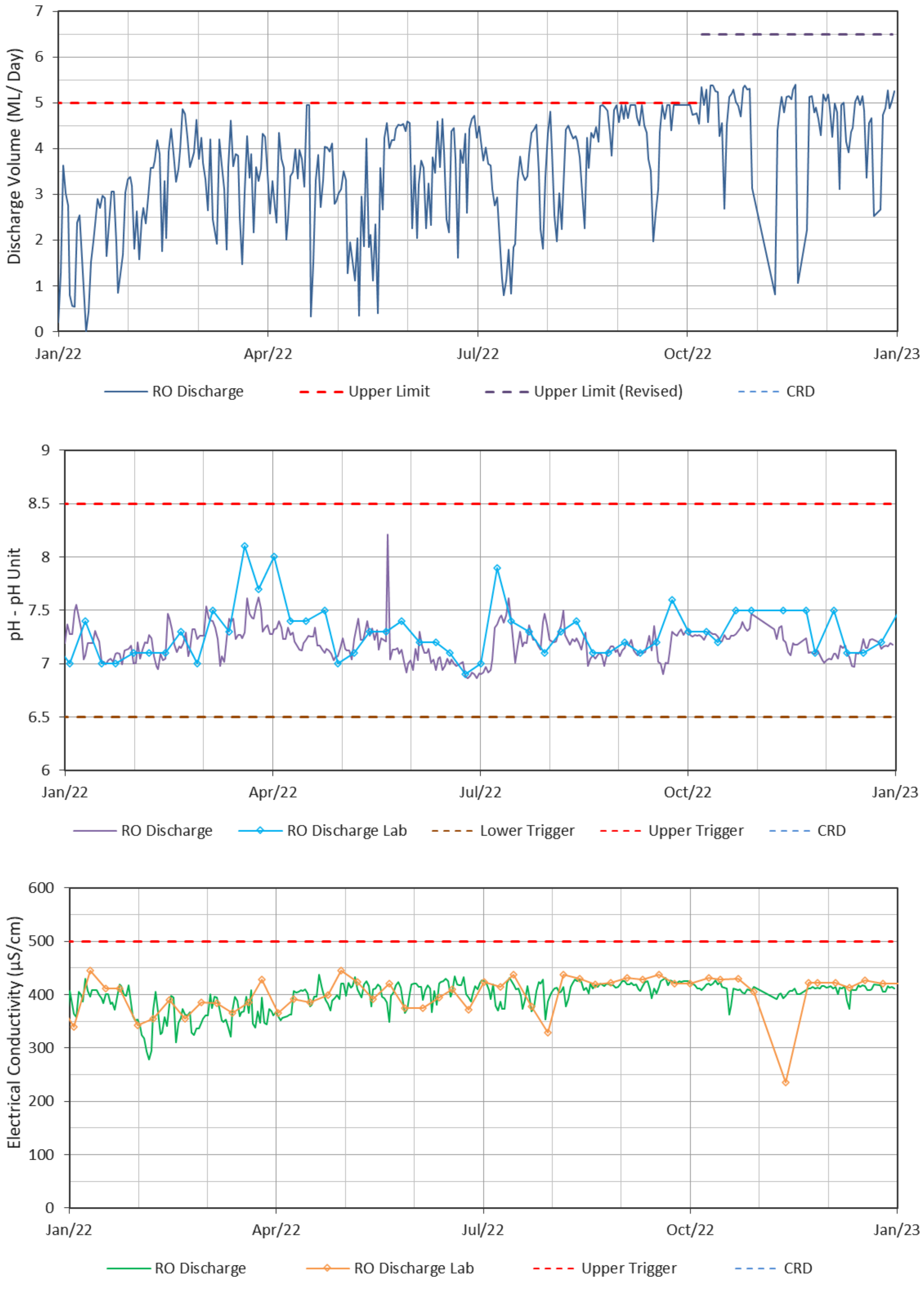

Figure 3 RO Plant discharge volume and quality in 2022

3.2.2 EPL Point 30 - Pit 8 Clean Water Discharge

WCM discharges surface water run-off captured above mining operations at EPL Point 30. This area above mining operations is referred to as the Pit 8 clean water dam (CWD). The turbidity value measured in the discharge at EPL Point 30 should not exceed the turbidity value measured at the Wilpinjong Creek upstream gauging station (WILGSU). The water discharged from EPL Point 30 is captured rainwater and should therefore have a water quality (i.e. turbidity) that is equal to or better than the turbidity of the receiving water in Wilpinjong Creek. When there is no flow within Wilpinjong Creek at the upstream gauging station the value of turbidity measured at EPL Point 30 must not exceed 50 Nephelometric Turbidity Units (NTU). , which is a 'limit' recommended in the 'Blue Book' (*Soils and Construction Volume 1 – Managing Urban Stormwater* – Landcom, 2004).

Discharge from EPL Point 30 - Pit 8 CWD point was recorded on 78 days in 2022 with a total of 269.5 ML released.

CF Hydrometrics have been engaged by WCPL to evaluate compliance with EPL Condition 2.5 on a monthly basis (pertaining to turbidity at EPL Point 30). CF Hydrometrics have confirmed that no licence exceedances occurred within the EPL Return Period (8 Feb 2022 to 7 Feb 2023).

4 2022 Monitoring Data Review

Flow rates and water quality (pH and EC) are monitored continuously from two sites on Wilpinjong Creek (WILGSU and WILGSD) and one site on Cumbo Creek (CCGSU).

The locations of the gauging stations on Wilpinjong Creek are shown in **Figure 1**. The upstream site (WILGSU) is located northwest of WCM. The downstream site (WILGSD) is northeast of WCM, downstream of the RO Plant and downstream of the confluence of Wilpinjong and Cumbo Creek. The Cumbo Creek upstream gauging station (CCGSU) is located approximately 400 m to the East of Pit 2 and approximately 800m upstream of active mining at Pit 4 (**Figure 1**). Flow/discharge, electrical conductivity, and pH are all measured and presented against the rainfall trend from the local rainfall station (Wollar, 062032).

4.1 Surface Water Flow

The following section presents and discusses daily flow data from three continuous surface water monitoring gauges on Wilpinjong Creek (WILGSU and WILGSD) and Cumbo Creek (CCGSU). Observed flow trends are reviewed against rainfall and discharge volumes throughout 2022.

The two Wilpinjong Creek gauging stations have been recording since January 2012. The catchment area reporting to the upstream site (WILGSU) is 86 km^2 while the downstream site has a catchment area of 216 km^2. CCGSU on Cumbo Creek has been recording data since August 2015. **Figure 4** shows flow trends at these sites in 2022 compared to the RO Plant (EPL Point 24), Pit 8 CWD (EPL Point 30) and emergency provision discharge volumes.

- During 2022, flow at CCGSU fluctuates between 1 and 650 ML/day in response to rainfall events, with the highest flow events recorded in July (500 ML/day) and October (650 ML/day) 2022. CCGSU was observed to flow for the majority of the year with the exception of two brief periods in February and March.

- Flows were observed for the entire monitoring period in both WILGSU and WILGSD throughout 2022, consistent with above average rainfall. WILGSU (0.25-802 ML/day) and WILGSD (1.5-1,200 ML/day). Wilpinjong Creek flow monitoring sites maintained higher flow rates compared to CCGSU in late 2022. This is due to discharge of mine water under emergency and licenced provisions by both Wilpinjong and Moolarben Coal supplementing natural flow.
- **Table 5** presents the calculated daily mean discharge from WILGSU, WILGSD and CCGSU for each year since 2013. The average daily flow rate of all creek monitoring points has increased from 2019 through 2022 with all sites showing the highest daily averages since 2013 in the last year.

Table 5 Calculated daily mean flow rate at Wilpinjong and Cumbo Creeks

Monitoring Location	Average Daily Flow Rate (ML/day)									
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
WILGSU	0.16	0.03	0.24	2.8	0.002	0	0	5.2	5.1	25.8
WILGSD	0.27	0.22	0.39	5.7	5.9	0.73	0.008	6.0	10.0	70
CCGSU	No data		0.14	1.6	0.6	0.4	0.1	0.9	2.1	20.4

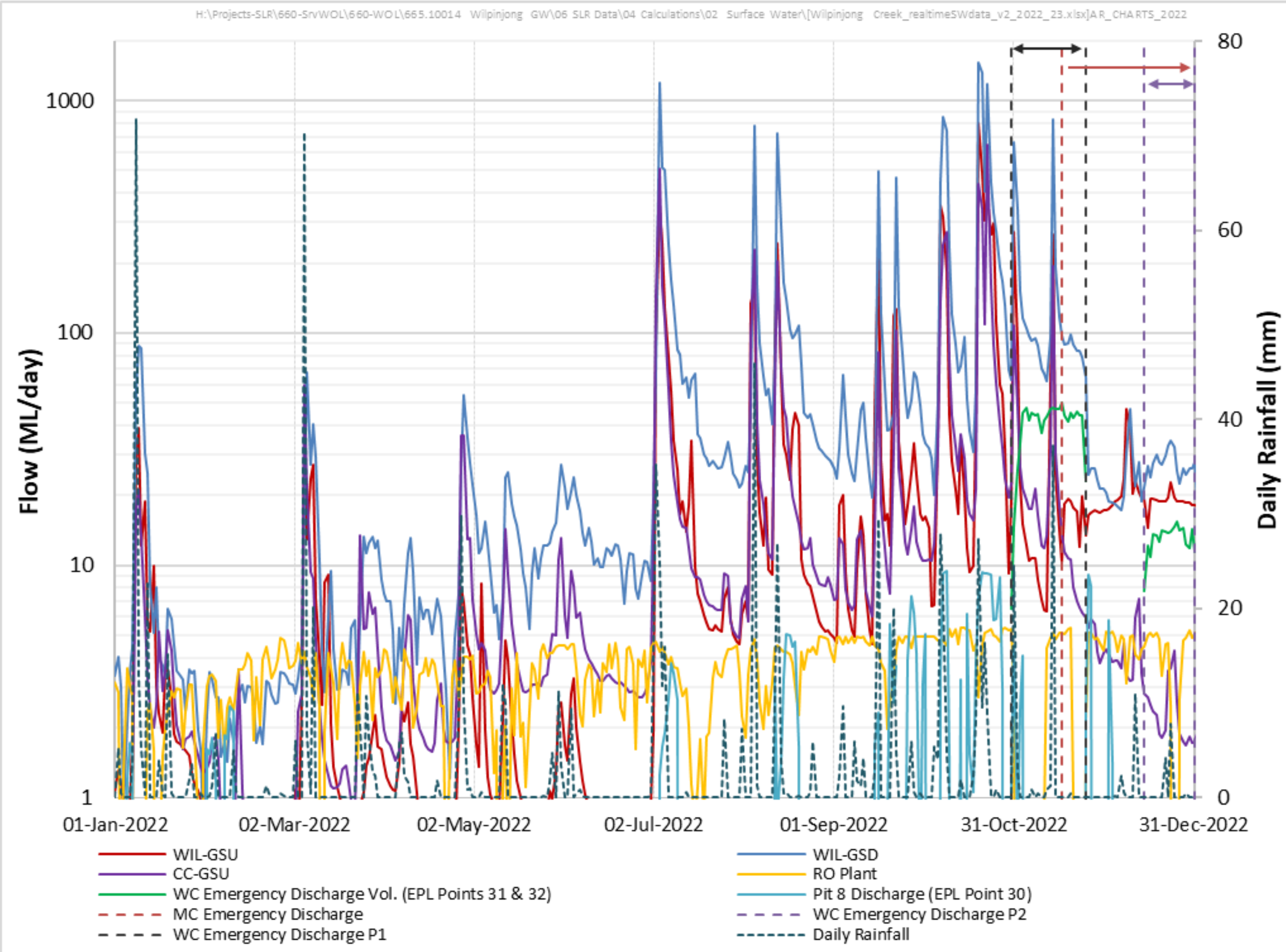

Figure 4 Continuous flow monitoring near Wilpinjong Coal Mine

4.2 Water Quality

Water quality is monitored continuously at WILGSU, WILGSD and CCGSU, with a multi parameter water meter (sonde) measuring EC, pH (and temperature, which is not provided here). Real-time water quality data from the WaterNSW *Goulburn River at Coggan* (210006) site has been included in charts as Goulburn River was identified as a key downstream receptor of the water discharged under emergency provisions in late 2022.

4.2.1 Electrical Conductivity

Trends in Electrical Conductivity (EC) at WILGSU, WILGSD and CCGSU are generally influenced by the following factors:

- WILGSU is most strongly influenced by the rainfall trend, with limited contribution identified from groundwater (baseflow). EC at WILGSU is therefore generally low (~1,000 µS/cm) and relatively consistent, with a minor inverse response to the rainfall trend (lower rainfall results in an increase in EC) likely resulting from increased evaporation and lower contribution of fresh water in periods of low rainfall.

- Flow at CCSGU is likely to have a persistent groundwater contribution that is sourced from weathered Permian coal measures. This results in observations of EC between 6,000 and 8,000 µS/cm). Declines in EC are observed following peak rainfall events.
- Flow at WILGSD is influenced by upstream flow from both Wilpinjong and Cumbo Creeks as well as the RO Plant, which all have different EC values. EC at WILGSD is therefore variable and related to the primary source of flow at any point in time.

In 2022 continuous monitoring at Cumbo Creek (CCGSU) showed a declining EC trend (from ~4,000 µS/cm to 2,000 µS/cm) likely resulting from above average rainfall (**Figure 5**). Both WILGSU and WILGSD displayed generally declining EC levels until late 2022 of around 500 µS/cm upstream and 1,000 µS/cm downstream. In late 2022, EC at Wilpinjong Creek sites increased in response to EMW discharge from Wilpinjong and Moolarben coal mines upstream as part of permitted emergency discharge provisions (**Figure 5**).

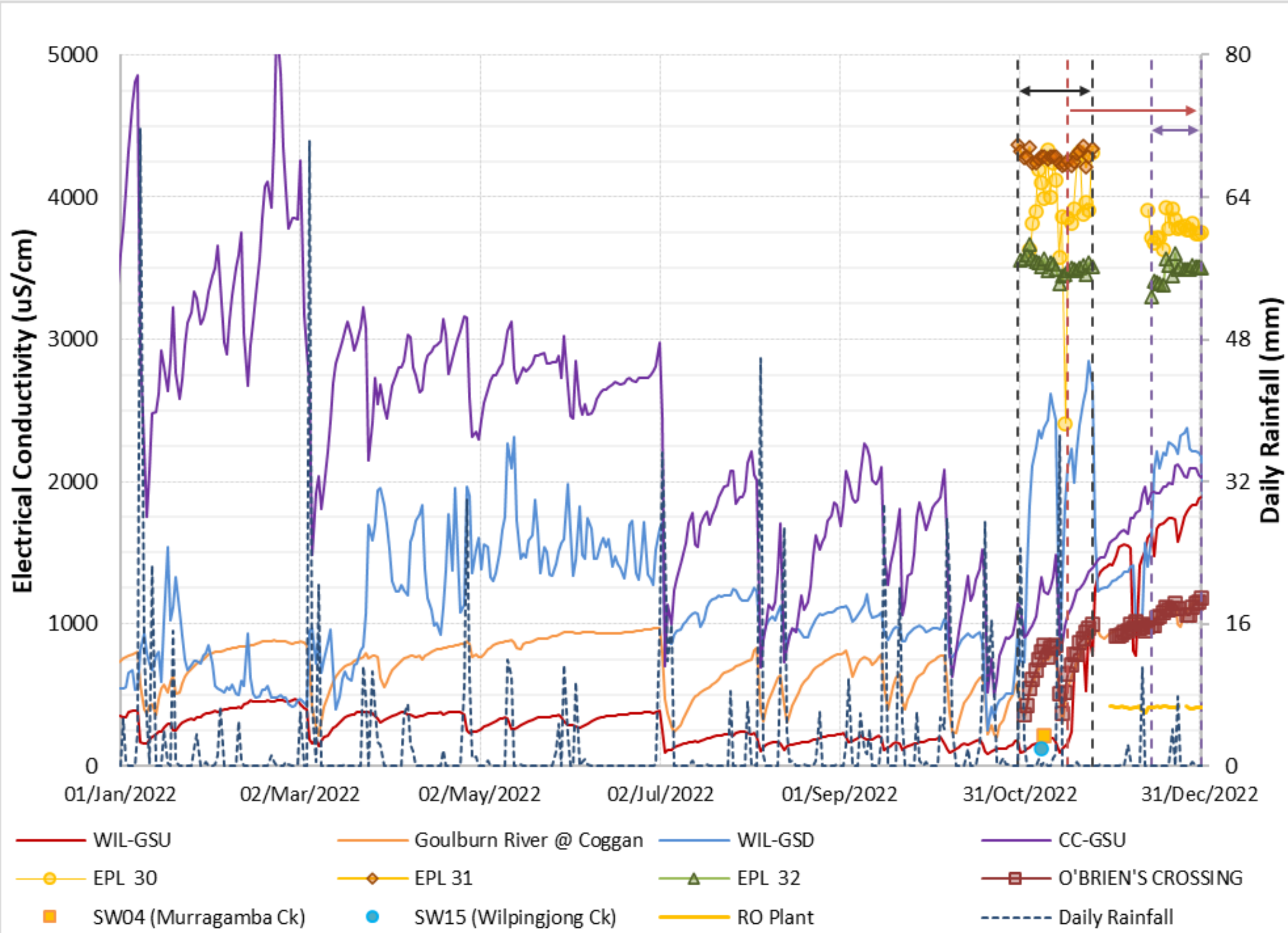

Figure 5 Continuous EC monitoring at Wilpinjong Coal Mine

4.2.2 pH

pH at CCGSU is generally consistent throughout 2022, with pH around pH 7.2 to 7.5, showing minor decreases following periods of higher rainfall, which has lower pH (**Figure 6**).

pH at both gauging stations on Wilpinjong Creek are different by about 1 pH unit and show some correlation to periods of rainfall (declining with higher rainfall periods).

For most of 2022 the pH levels in Wilpinjong Creek show some variability that appears linked with periods of high rainfall. WILGSD varies from pH 6.5 to 8 and WILGSU varies from pH 5.5 to 7. In late 2022, both WILGSU and WILGSD show an increase in pH that is likely related to the higher pH of water discharged to Wilpinjong Creek under emergency provisions.

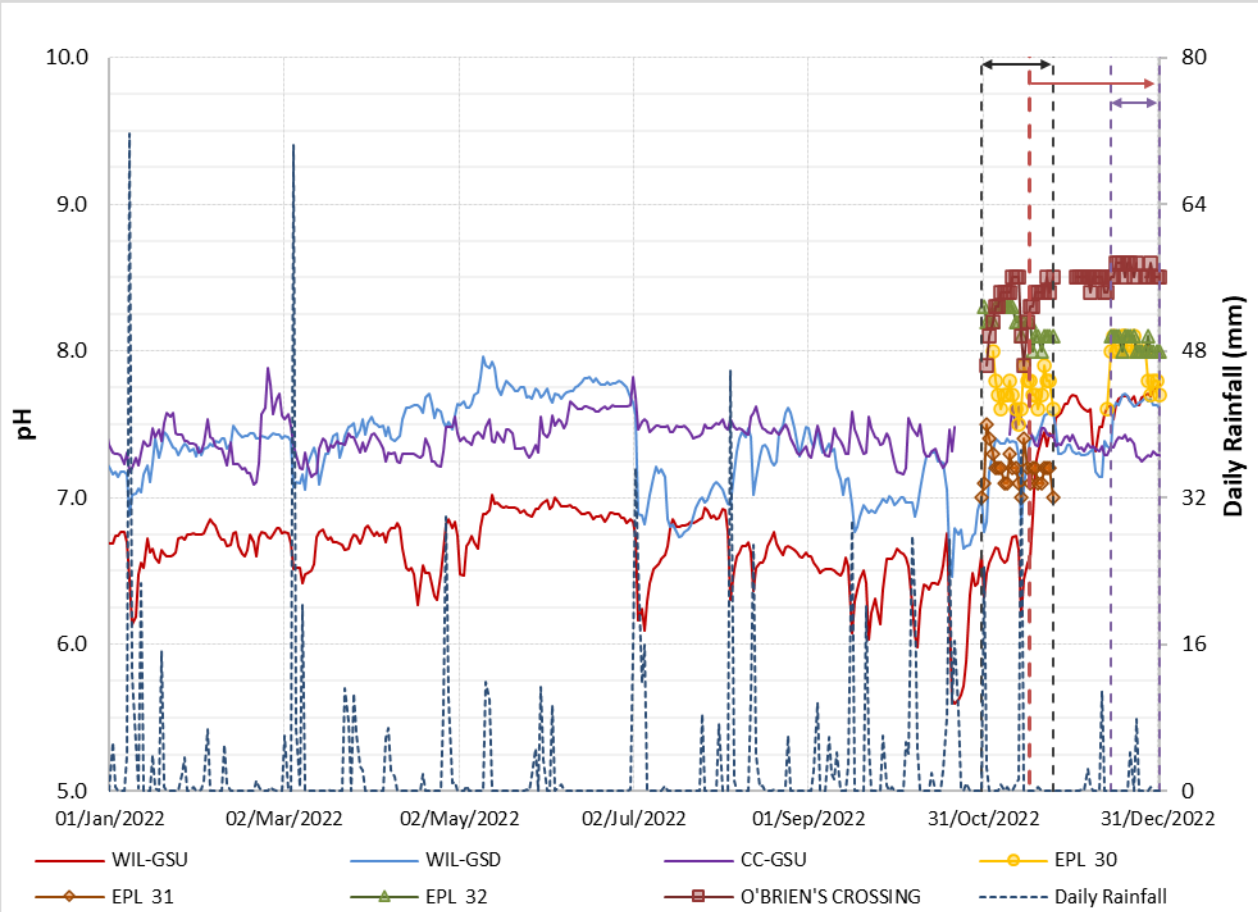

Figure 6 Continuous pH monitoring at Wilpinjong Coal Mine

5 Water Quality Trend Analysis

The following section reviews surface water quality data from monitoring sites specified in Section 8 of the Surface Water Management Plan (WCPL, 2017). This has been conducted with respect to 20th and 80th percentile baseline monitoring data (**Table 6**) (which was collected from 2004 to 2009, prior to the commencement of mining) and water quality impact assessment criteria (trigger levels) where defined (**Table 7**).

Table 6 Summary of Baseline Water Quality Data – Local Creeks (WCPL, 2017)

Monitoring Site/Guideline		pH	EC (µS/cm)[1]	Turbidity (NTU)[1]
ANZECC (2000) Guideline Trigger Value	**Protection of Aquatic Ecosystems**	6.5-8.0	30-350	2-25
	Primary Industries (Livestock Drinking Water)	6-9	950	-
Wilpinjong Creek Upstream (Sites WIL-U2, WIL-U, WIL 1, WIL-PC)	Average	7	2,435	20
	Minimum	5.7	450	6
	Maximum	9	12,190	41
	No. Samples	49	49	5
	80th percentile	**7.7**	**4,066**	**24**
	20th percentile	**6.9**	-	-
Wilpinjong Creek Downstream (Sites WIL-NC, WIL-D2, WIL 2, WIL-D)	Average	8	3,531	22
	Minimum	6.7	680	4
	Maximum	9	7,450	70
	No. Samples	55	55	9
	80th percentile	**7.9**	**5,166**	**28**
	20th percentile	**7.4**	-	-
Cumbo Creek Upstream (Sites CC2, CC3, CC4, CC5)	Average	8	5,303	11
	Minimum	6.8	100	5
	Maximum	9	10,500	24
	No. Samples	70	70	15
	80th percentile	**8.2**	**6,750**	**16**
	20th percentile	**7.4**	-	-
Cumbo Creek Downstream (Site CC1)	Average	8	6,231	43
	Minimum	6.7	540	17
	Maximum	9	10,470	94
	No. Samples	27	27	6
	80th percentile	**8.2**	**7,510**	**77**
	20th percentile	**7.52**	-	-
Wollar Creek (Sites WOL 1, WOL 2, WOL 3)	Average	8	2,311	16
	Minimum	6.5	90	2
	Maximum	8.4	6,540	37
	No. Samples	90	90	20
	80th percentile	**8.0**	**3,460**	**25**
	20th percentile	**7.4**	-	-

[1] µS/cm = micro-siemens per centimetre, NTU = Nephelometric Turbidity Units, mg/L = milligrams per litre

Where trigger levels are defined (**Table 7**) the review will identify any exceedances and provide preliminary analysis.

Table 7 Water Quality Impact Assessment Criteria (WCPL, 2017)

Creek	Monitoring Site	Parameter	Trigger
Wilpinjong Creek (Downstream)	WIL_NC, WIL_D2, WIL_D, WIL_2	EC	If recorded value at the monitoring site is greater than **3,440 µS/cm** for 3 consecutive readings
		Turbidity	If recorded value at the monitoring site is greater than **24 NTU** for 3 consecutive readings
		pH (lower)	If recorded value at the monitoring site is less than **6.9 pH** for 3 consecutive readings
		pH (upper)	If recorded value at the monitoring site is greater than **7.7 pH** for 3 consecutive readings
Cumbo Creek (Downstream)	CC1	EC	If recorded value at the monitoring site is greater than **7,510 µS/cm** for 3 consecutive readings
		Turbidity	If recorded value at the monitoring site is greater than **77 NTU** for 3 consecutive readings
		pH (lower)	If recorded value at the monitoring site is less than **7.5 pH** for 3 consecutive readings
		pH (upper)	If recorded value at the monitoring site is greater than **8.2 pH** for 3 consecutive readings

[1] Trigger is only considered to have been exceeded if the recorded value at monitoring site is greater than (or less than for lower pH Trigger) all values from the upstream monitoring sites sampled on the same day. In the event that a single result is recorded above/below the 80th/20th percentile value, WCPL will undertake a preliminary investigation to ascertain whether the result was caused by an obvious anomaly or whether further testing is required.

5.1 Wilpinjong Creek Upstream

The creek area defined as Wilpinjong Upstream (WCPL, 2017) is assessed using monitoring data from sites WIL-U2, WIL-U, WILGSU and WIL-PC (**Table 6**). These sites are located along Wilpinjong Creek near the western edge of the current and proposed WCM mining activity (**Figure 1**).

5.1.1 Electrical Conductivity

EC observations at Wilpinjong Creek Upstream monitoring sites have shown considerable variation between 2015 and 2022 (<1,000 µS/cm to 6,000 µS/cm). More elevated observations (>4,000 µS/cm) are observed at WIL-U WIL-U2 and WIL-PC and are observed to occur simultaneously with fresher observations at WIL-GS-U (~2,000 µS/cm). This indicates EC observations at these sites may be influenced by localised effects in lower or average flow and rainfall conditions. A notable freshening at all Wilpinjong Creek Upstream sites occurs in late 2016, and from 2020 to the end of 2022, in response to above average rainfall conditions. Until late 2022, all monitoring locations show similar trends which is consistent with above average rainfall influencing water quality. The observed increase in EC at the end of 2022 is likely related to the discharge of excess mine water from Moolarben Coal mine further upstream under emergency provisions. EC observations at Wilpinjong Creek Upstream monitoring sites are well below the 80th percentile baseline (4,066 µS/cm) for 2022.

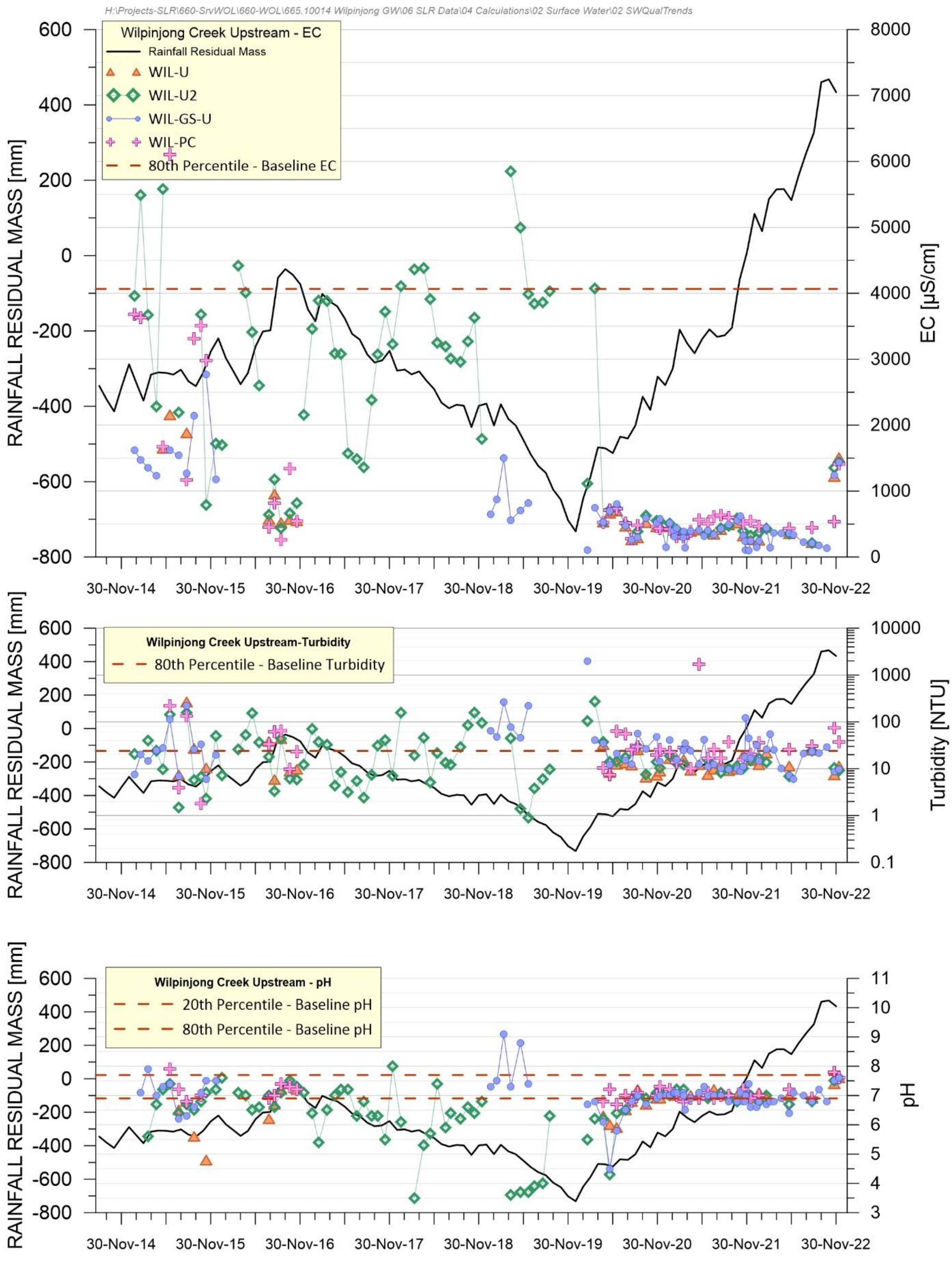

Figure 7 Time-series water quality for Wilpinjong Creek Upstream

5.1.2 Turbidity

Turbidity observations at Wilpinjong Creek Upstream monitoring sites continuously fluctuate between 2015 and 2022, with observations ranging from 6.6 – 2,000 NTU, and are above the 80th percentile baseline monitoring value (24 NTU) for around half of the observations. Turbidity observations with higher values generally appear to be associated with periods of below average rainfall.

During 2022, turbidity observations generally ranged from 5 - 80 NTU with few outliers, again showing connectivity of the sites during periods of above average rainfall and flow. Initial peaks in 2020 (100 - 1,000 NTU at WIL-GS-U and WIL-U2) are likely related to an increased load of fine sediment being flushed down Wilpinjong Creek after low and no flow conditions since 2017. While more consistent flow conditions in 2021 and 2022 have likely resulted in the more stable turbidity observations.

Flow conditions (influenced by rainfall trends) are considered to be the primary drivers of turbidity observations at Upstream Wilpinjong Creek monitoring sites.

5.1.3 pH

pH observations at the Wilpinjong Creek Upstream monitoring sites during 2022 are relatively stable and near neutral, with pH at all sites ranging from pH 6.4 to 7.2 until late 2022. An increase in pH in November and December 2022 (between pH 7.5 and 8) may have been caused by discharge from Moolarben Coal Mine upstream under emergency discharge provisions.

The majority of the 2022 observations at upstream Wilpinjong Creek sites are near the 20th percentile baseline monitoring value (pH 6.9), which is consistent with an extended period of above average rainfall, noting that pure rainwater is generally pH 5.3.

Rainfall, and subsequent flow conditions are therefore considered to be the primary drivers of pH observations at upstream Wilpinjong Creek monitoring sites with some influence late in the year from permitted discharge upstream.

5.2 Wilpinjong Creek Downstream

The creek area defined as Wilpinjong Creek Downstream (WCPL, 2017) is assessed against water quality trigger levels at sites WIL-NC, WIL-D2, WIL-D and WIL-GS-D (**Table 7**). These sites are located along Wilpinjong Creek, adjacent to, or just downstream of WCM mining operations and Cumbo Creek (for sites other than WIL-NC) (**Figure 1**).

5.2.1 Electrical Conductivity

As discussed in **Section 4.2,** EC observations at Wilpinjong Creek Downstream monitoring sites are influenced by upstream flow from Wilpinjong Creek, flow from Cumbo Creek, discharge permissible under EPL 12425, and some contribution of baseflow. This has resulted in higher EC observations in periods of low flow, above the defined trigger level in 2015 and 2019, attributed to greater contributions from baseflow or Cumbo Creek flow. Also observed are longer periods of consistently low EC observations from 2016 to 2018 attributed to fresh RO Plant discharge.

Until late 2022, EC observations at the Wilpinjong Creek Downstream monitoring sites were well below the 80th percentile baseline as well as below the trigger level (3,440 µS/cm) which is related to above average rainfall and high flow conditions in 2022. In late 2022 (December), EC increased at all Wilpinjong Creek downstream monitoring locations, which is most likely related to higher EC water being discharged to Wilpinjong Creek under emergency provisions. While WIL-NC has one observation above the trigger level (November 2022), this does not fulfil the criteria of a trigger exceedance.

5.2.2 Turbidity

Turbidity observations at monitoring sites in the Wilpinjong Creek downstream area show some variability from 2015 to 2022 (1-1,000 NTU) (**Figure 8**), with a minor inverse relationship to the rainfall trend.

During 2022, turbidity observations at Wilpinjong Creek Downstream monitoring sites are generally below the 80th percentile baseline (28 NTU) and trigger level (24 NTU) with two non-consecutive observations for WIL-D (December 2022) and WIL-GS-D (March 2022) above the trigger level in 2022. Three consecutive readings were not observed above the trigger level at any site in 2022, and the observations are also lower than those recorded at upstream monitoring sites. As described in the paragraph above, this does not constitute an exceedance of the trigger level.

5.2.3 pH

pH at the monitoring sites in the Wilpinjong Creek downstream area were reasonably consistent from 2015 to the end of 2017. During early 2018 and from 2019 to early, Wilpinjong Creek downstream sites recorded pH levels considerably lower than the lower trigger value (pH 6.9). However, due to low pH values observed simultaneously at Wilpinjong Creek Upstream monitoring sites (**Figure 7**), this has not constituted a trigger exceedance. As was proposed in **Section 4.2.2**, this decline in pH may be associated with saline groundwaters or groundwater discharge into the system, hosting chemical changes such as conversion of sulphates to sulphides, leading to acid generation.

During 2022, pH observations at Wilpinjong Creek Downstream monitoring sites are above upper trigger values (pH 7.7) at WIL-D2 (3 consecutive observations from May-November 2022) and WIL-D (5 consecutive observations from April-August 2022). A similar trend was not observed at Wilpinjong Creek Upstream monitoring sites, therefore breaching the upper pH trigger level as defined in the SWMP (WCPL, 2017) (**Table 7**).

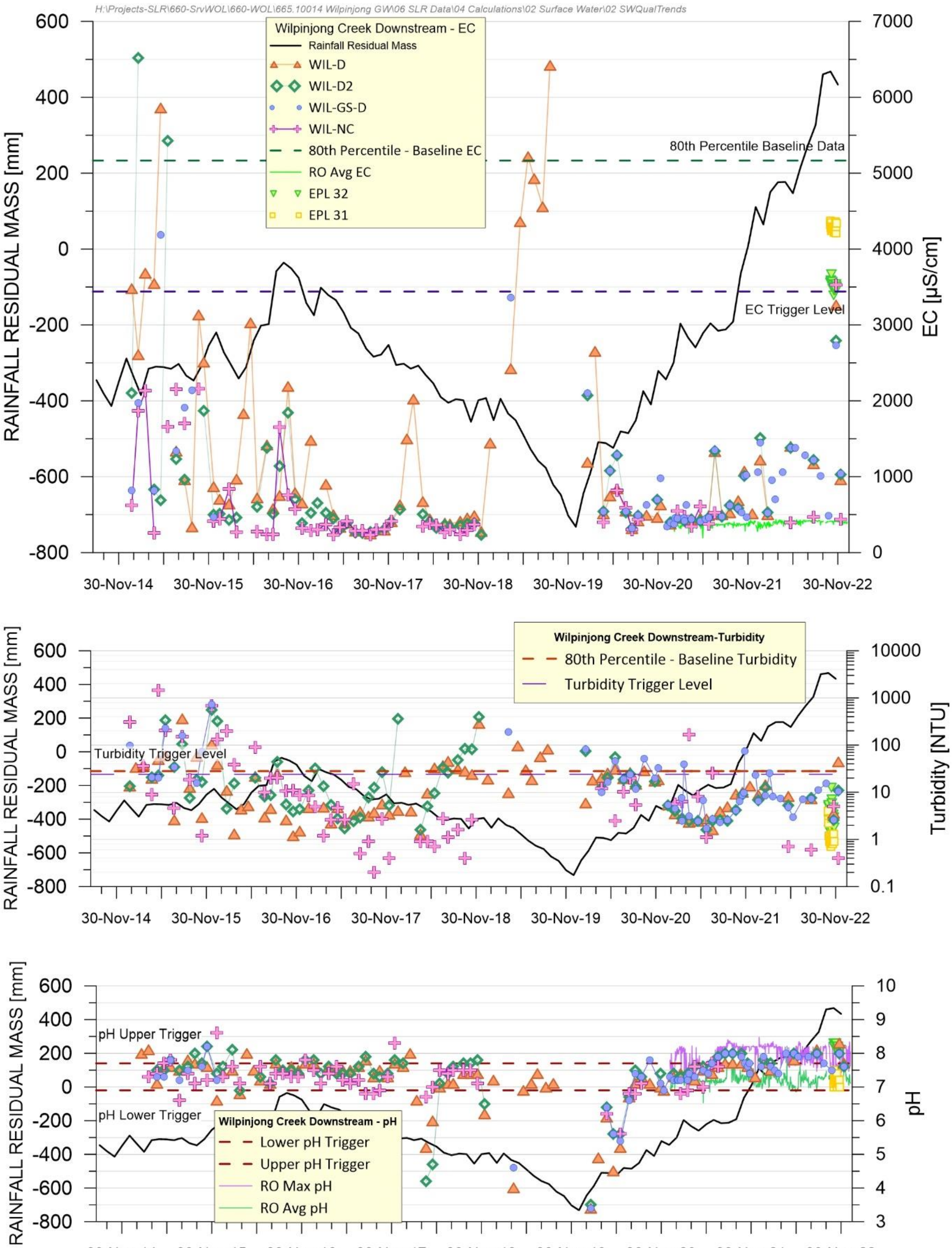

Figure 8 Time-series water quality for Wilpinjong Creek Downstream

5.2.4 Trigger Exceedance

The following points provide an overview of the data considered to evaluate the likelihood of the pH trigger exceedance being related to WCM operations:

- Observations at downstream Wilpinjong Creek sites (WIL-GS-D, WIL-D2, WIL-D) in late 2022 generally return to or below the trigger level, indicating the trigger exceedance did not worsen over time.
- The sites exceeding trigger levels are ~1 pH unit higher than observations at upstream sites, consistent with previous observations. Continuous monitoring from water quality sonde indicate Wilpinjong Creek downstream sites have consistently (since 2012) been recorded 0.5-1 pH unit higher than upstream sites (**Section 4.2.2**).
- It is also noted that downstream pH from continuous monitoring at WILGSD is generally below the trigger level throughout 2022 (**Figure 6**). The relationship between the pH recorded at the continuous monitoring sondes and in periodic sampling could be reviewed to assess the quality of the observation data indicating the trigger exceedance.
- Baseline pH data collected for downstream Wilpinjong Creek sites have a 20th percentile value of pH 6.9 and an 80th percentile value of pH 7.9 (**Table 6**). Thus, under normal conditions, pH observations are expected to be higher than pH 7.9 20% of the time, meaning a trigger level of pH 7.7 may be too low to meaningfully indicate a potential Wilpinjong Coal mining effect that justifies further investigation.
- The maximum daily pH value for RO plant discharge is observed to be at or above the pH trigger level for most of 2022 (**Figure 8)**, while the average discharge pH is 7-7.5. During lower flow conditions, the maximum pH from the RO plant may have some influence on pH sampled at downstream Wilpinjong Creek sites, however, this is unlikely in 2022 due to high flow conditions from above average rainfall. It is noted that that the upper pH discharge limit for EPL Point 24 is pH 8.5, higher than the trigger level (**Section 3.2.1**).
- Higher pH surface water is present locally, outside the influence of WCM operations. The exceedance is therefore unlikely to pose a threat to the health of local ecosystems. Observations in 2022 of pH 7.5-8 at upstream Wollar Creek (WOL2), and ~pH 8.5 at upstream Cumbo Creek (CC-3) are consistent with available historical data.

Higher pH surface water is naturally occurring in the Wilpinjong area, pH at downstream Wilpinjong Creek is generally higher than upstream, and pH continuous monitoring does not indicate elevated pH in 2022. It is also noted that the 80th percentile baseline pH for downstream Wilpinjong Creek sites is pH 7.9, indicating that trigger level of pH 7.7 might not meaningfully capture observations that indicate a Wilpinjong mining effect.

The current trigger level could be revised (increased from pH 7.7 to pH 7.9) to reflect the 80th percentile baseline data for downstream sites.

5.3 Cumbo Creek Upstream

The creek area defined as Cumbo Creek Upstream (WCPL, 2017) is assessed using monitoring data from sites CC2, CC3, CC-GS and CC-GS-U (**Table 6**). These sites are located along Cumbo Creek to the south of WCM (**Figure 1**).

5.3.1 Electrical Conductivity

EC observations at Cumbo Creek Upstream show considerable variation between 2015 and 2022 (<1,000 µS/cm to ~10,000 µS/cm) but are generally brackish to saline. Freshening may occur following increases in the long-term rainfall trend as is seen in late 2016, and again from mid-2021 to the end of 2022, with the inverse observed in periods of low rainfall. During 2022 EC observations freshened with the increasing rainfall trend. Observations at all sites were below the 80th percentile baseline (6,750 µS/cm) and reduced to <2,000 µS/cm. This is likely related to fresh rainfall-runoff mixing with ongoing saline groundwater inflow contributions in Cumbo Creek.

A combination of rainfall, subsequent flow and ongoing baseflow contributions are considered to be the primary drivers of EC observations at Cumbo Creek monitoring sites.

5.3.2 Turbidity

Turbidity observations at Cumbo Creek Upstream monitoring sites from 2015 to 2022 were generally below the 80th percentile baseline value for data collected from 2004 to 2009 (16 NTU). Higher values (1,000-10,000 NTU), which are not clearly linked with the rainfall trend, occurred throughout 2015 and again in early-2018.

Observation data shows the turbidity in 2022 ranged from <1 to ~15 NTU. Turbidity observations at Cumbo Creek Upstream sites are below the 80th percentile baseline level (16 NTU) for all 2022.

It is noted that CC-3 is located south of WCM, adjacent to Wollar Road. It is possible that additional runoff from Wollar Road at this location is contributing to the higher turbidity observations at CC-3 compared with CC-2 and CC-GS-U.

5.3.3 pH

pH observations at Cumbo Creek Upstream have been relatively stable from 2015 through 2022, and generally range from pH 7.5 – 8.5. The most upstream site, CC-3, has reported observations of approximately pH 8.5 from 2015-2022 while CC-2 and CC-GS-U were closer to pH 8. During early 2022, pH observations at CC-2 and CC-GS-U were recorded within both the 20th and 80th percentile baselines with CC-3 showing more alkaline readings, consistent with observations since 2015. pH observations through the remainder of 2022 generally fell between the 20th (pH 7.4) and 80th (pH 8.2) percentile baseline values.

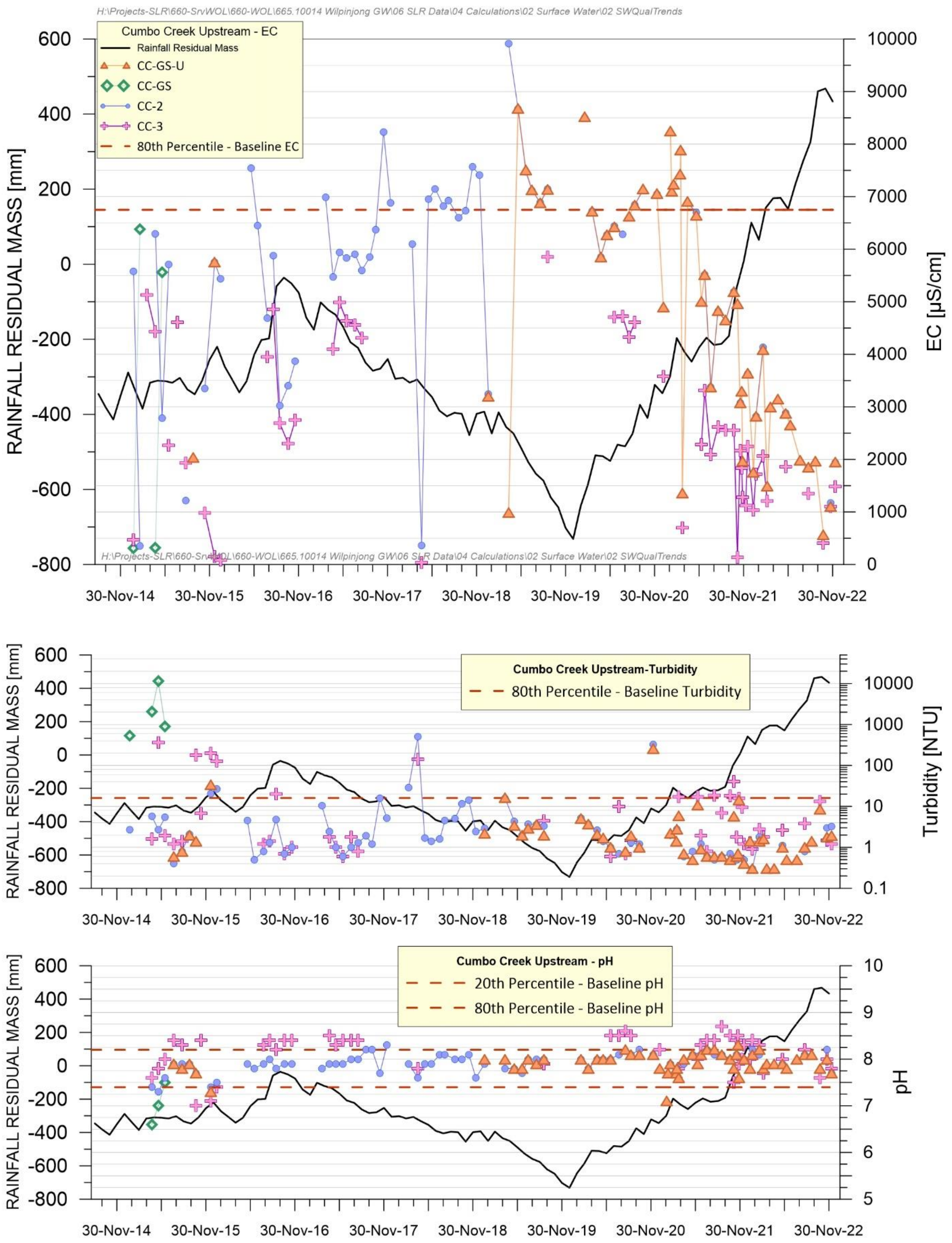

Figure 9 Time-series water quality for Cumbo Creek Upstream

5.4 Cumbo Creek Downstream

The creek area defined as Cumbo Creek Downstream is assessed against water quality trigger levels at site CC1, CC-GS-D, CC-1-(up 30m) (**Table 7**). These sites are located close to the confluence of Wilpinjong and Cumbo Creeks and are near the northern extent of the WCM mining operations (**Figure 1**).

5.4.1 Electrical Conductivity

EC observations at Cumbo Creek Downstream monitoring sites show considerable variation from 2015 through 2022 (<1,000 µS/cm to ~6,400 µS/cm) but have not recorded an observation above the trigger level since 2015 (7,510 µS/cm).

During 2022, EC observations at Cumbo Creek Downstream monitoring sites are well below the trigger level (7,510 µS/cm) with readings between <1,000 and 4,000 µS/cm.

5.4.2 Turbidity

Aside from a single observation at CC-1-(up 30m) turbidity observations at Cumbo Creek Downstream monitoring sites in 2022 are below the trigger level (77 NTU). CC-1-(up 30m) will not be sampled in the future as access can be unsafe and sampling is frequently unsuccessful due to a lack of observable surface flow.

No exceedance of the trigger level was recorded during 2022 as three consecutive observations above the trigger level are required at CC-1.

The following comments are made regarding water sampling at downstream Cumbo Creek sites:

- Previous investigations of surface water quality at WCM (SLR, 2021 and SLR, 2020) have identified the public Ulan-Wollar Road to be a potential source of sediment at CC-1 and CC-GS-D monitoring sites. Sediment deposition is also noted at this location in aerial imagery from 2021. It is difficult to separate potential WCM impacts on Cumbo Creek from those caused by runoff from Ulan-Wollar Road.
- CC-1 and CC-GS-D are located in close proximity to each other and often sample the same analytes on the same date.

Sampling methodology of the downstream water quality sites at Cumbo Creek could be updated to consider the potential influence of Ulan-Wollar Road on water quality observations at the time of sampling. When flow is observed at sites downstream of Ulan-Wollar Road), runoff contribution from Ulan-Wollar Road should be checked, noted on sampling sheets, and photographed at the time of sampling . This will help evaluate the contribution of runoff from the road on the collected water sample.

5.4.3 pH

From 2015 to early 2019, pH observations at Cumbo Creek Downstream monitoring sites are consistently below the trigger level defined in the SWMP (WCPL, 2017) at a level of around pH 7 (**Figure 10**). They are also generally lower than pH observations from Cumbo Creek Upstream monitoring sites (**Figure 9**).

Throughout 2022 all monitoring sites, CC-1, CC-1 (30m up) and CC-GS-D, were within the pH trigger levels (pH 7.5-8.2) at Cumbo Creek downstream sites. No pH trigger exceedance was recorded in 2022 as more than three consecutive observations were not below the lower pH trigger level at CC1.

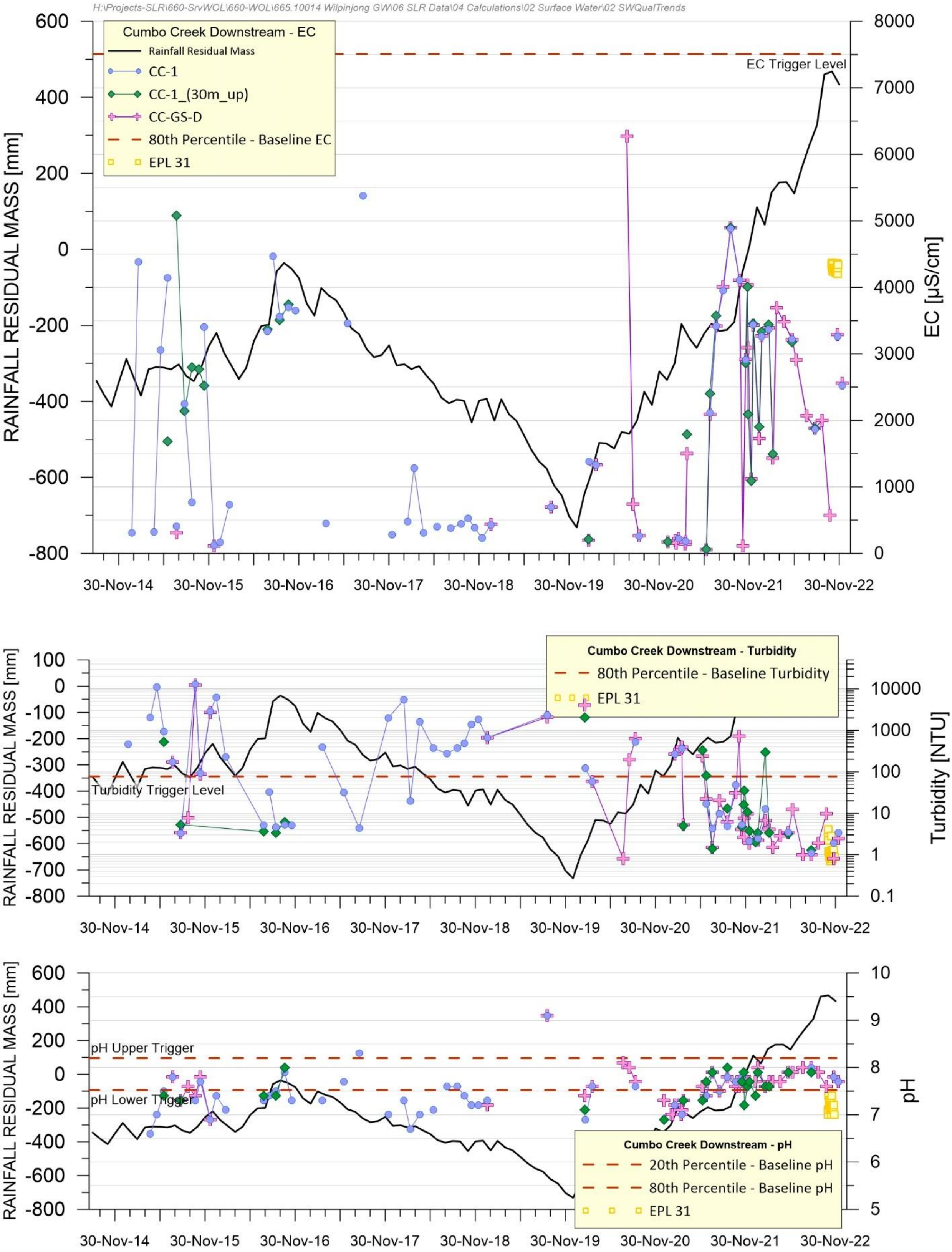

Figure 10 Time-series water quality for Cumbo Creek Downstream

5.5 Wollar Creek

Wollar Creek is assessed using monitoring data from sites WOL1, and WOL2 (**Figure 1**). The sites are located along Wollar Creek to the east and south of WCM, with WOL1 located downstream of the confluence between Wilpinjong and Wollar Creeks. The Wollar Creek monitoring sites are located approximately 5 km from the current extent of the WCM mining activity.

5.5.1 Electrical Conductivity

EC observations at both Wollar Creek monitoring locations show some influence from rainfall as well as baseflow from more saline groundwater.

In 2022, continued above average rainfall freshened Wollar Creek, with EC below the 80th percentile baseline values (<1,500 µS/cm). In late 2022, an EC observation at WOL-1 (downstream of the confluence with Wilpinjong Creek) showed an elevated EC which is most likely related to discharge from Wilpinjong and Moolarben Coal Mines under emergency provisions.

5.5.2 Turbidity

Turbidity observations at Wollar Creek monitoring sites have been relatively stable from 2015 through 2022 and have generally been recorded below the 80th percentile of baseline data collected from 2004-2009 (25 NTU).

Turbidity observations during 2022 at Wollar Creek monitoring sites were below the 80th percentile baseline (25 NTU) aside from a single observation at WOL-2 and were relatively stable during the increased rainfall trend. Overall, NTU readings for 2022 are consistent with the observed trend for the entire monitoring period (2015-2022).

5.5.3 pH

pH observations at Wollar Creek have been relatively stable from 2015 through 2022. WOL-1 observations have been marginally higher than the 80th percentile value defined from the baseline monitoring, while observations at WOL-2 were consistently within the 20th and 80th percentile bands defined in the baseline period.

In 2022 WOL-1 observations were pH 7.7-8.1, with some results above the 80th percentile baseline value (pH 8.0), while WOL-2 readings were within the 20th and 80th percentile baselines (pH 7.5-8) aside from a single observation (pH 8.2 in Aug 2022). The observations at both sites are consistent with observations from previous years and show minimal response to rainfall/ climatic conditions.

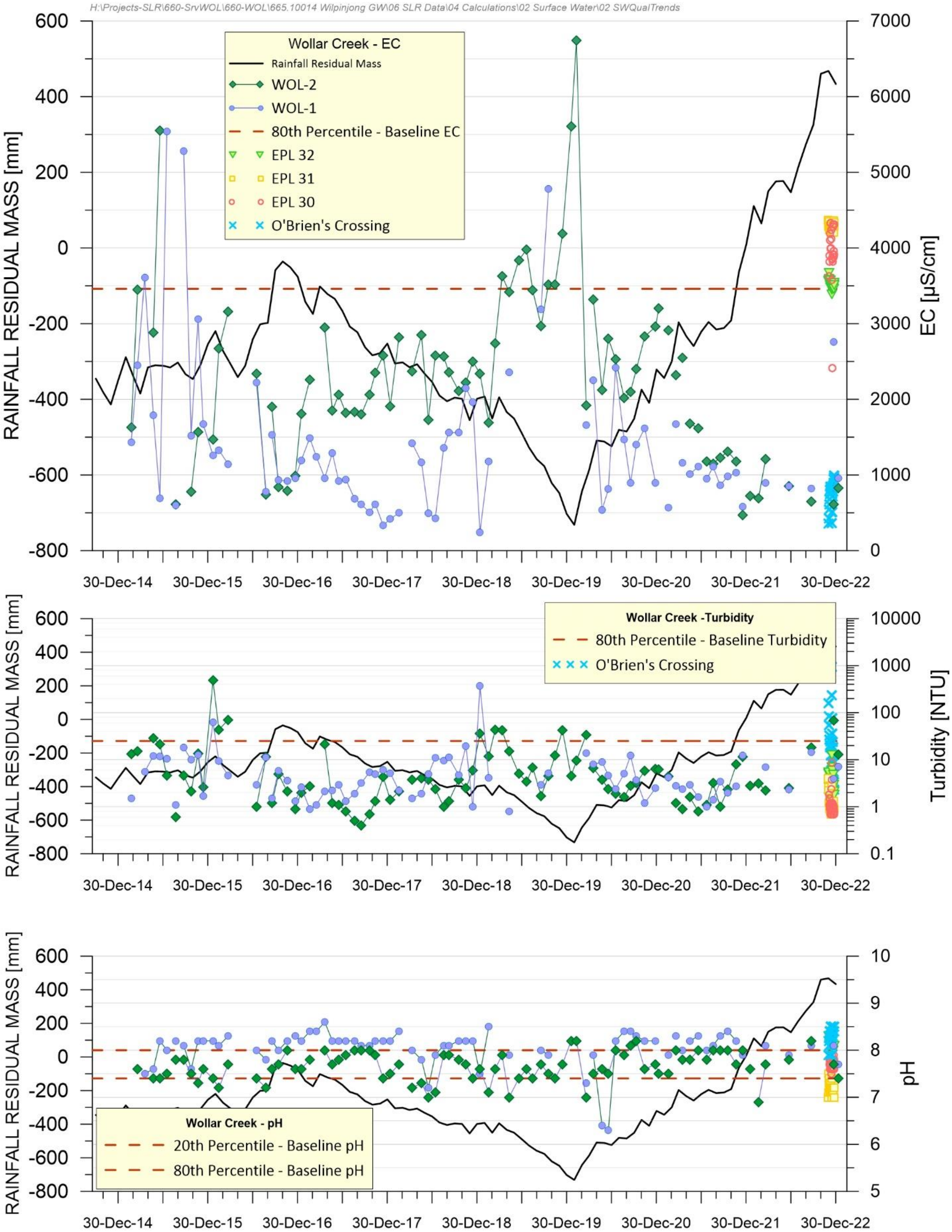

Figure 11 Time-series water quality for Wollar Creek

5.6 Assessment with respect to SWMP (WCPL, 2017) water quality triggers

Table 8 identifies Water Quality Impact Assessment Criteria defined in the SWMP (WCPL, 2017) that have been exceeded during 2022. This assessment, in line with the SWMP (WCPL, 2017) has only considered triggers to be exceeded under the following circumstances:

- *Trigger is only considered to be exceeded if recorded value at the monitoring site is greater than (or less than for lower pH trigger) for 3 consecutive readings.*
- *Trigger is only considered to have been exceeded if the recorded value at monitoring site is greater than (or less than for lower pH Trigger) all values from the upstream monitoring sites sampled on the same day.*

Table 8 Exceedances of Water Quality Impact Assessment Criteria (WCPL, 2017)

Creek	Site	Parameter	Trigger	Exceedance during 2022	Summary of Assessment
Wilpinjong Creek (Downstream)	WIL-NC, WIL-D2, WIL-D, WIL-2	EC	**3,440 µS/cm**	No	
		Turbidity	**24 NTU**	No	
		pH (lower)	**6.9 pH**	No	
		pH (upper)	**7.7 pH**	Yes	5 consecutive observations above the upper pH trigger at WIL-D2 3 consecutive observations above the upper pH trigger at WIL-D. Recommendations include: - Review periodic sampling quality against continuous monitoring to assess quality of observation data. - Consider requesting update of trigger level to reflect 80th percentile baseline data for downstream Wilpinjong Creek sites.
Cumbo Creek (Downstream)	CC1, CC-1-30m-up, CC-GS-D	EC	**7,510 µS/cm**	No	
		Turbidity	**77 NTU**	No	
		pH (lower)	**7.5 pH**	No	
		pH (upper)	**8.2 pH**	No	

6 Conclusions and Recommendations

Analysis of the available surface water data in 2022 indicates high rainfall influenced flow and water quality conditions for most of 2022, before observable influences from the discharge of EMW under permitted emergency discharge provisions occurred in late 2022. Under the emergency water discharge provisions of EPL 12443 There were periods where there were observable impacts from WCM mining operations on the adjacent creek lines, with exceedances of water quality monitoring criteria for Cumbo Creek downstream (lower pH) and Wilpinjong Creek downstream (upper pH) monitoring sites.

Due to exceedances of the surface water monitoring criteria, as defined in the SWMP (WCPL, 2017), SLR recommends that the currently established upper pH trigger level for Wilpinjong Creek downstream (**Table 7**) be made more relevant by being revised to reflect the 80^{th} percentile baseline value.

7 References

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